Can I recognize my body's weight?
The influence of shape and texture on the perception of self

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Introduction & Background

Human bodies are possibly the most familiar objects that people encounter. Body perception has been assessed using figure/image rating scales, drawing one's body and affordance measures. Body shape has been manipulated using distorted videos, mirrors or photographs. Distorted perception of own body is usually linked to patients with mental or eating disorders. However, recent research suggests that even healthy participants perceive a mismatch between their actual body size and their body image.

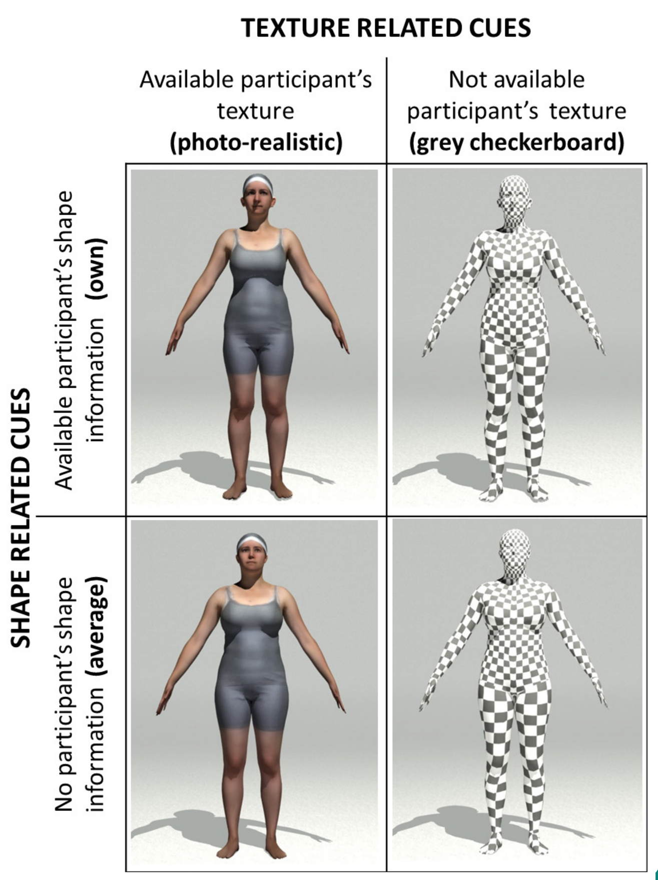
Goal

The goal of this research was to investigate women's sensitivity to changes in their perceived weight by altering the body mass index (BMI) of the participants' personalized avatars displayed on a large-screen immersive display and investigating the impact of visual cues (shape and texture).

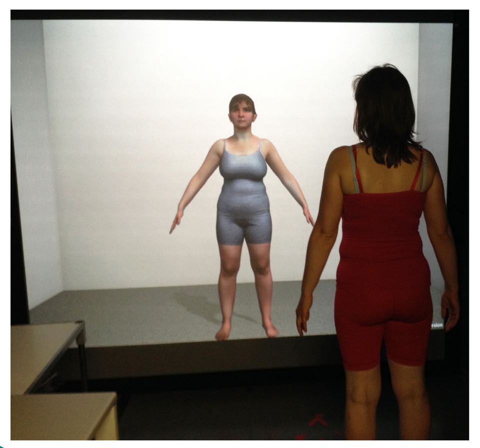
Experimental design & procedure

3-10 days after 3D scanning (due to post-processing), participants (N=13) performed 3 tasks:

- One interval two alternative forced choice (2AFC) task (180 Stimuli): *„Is it the same weight as you?" - Yes/No*
- Method of adjustment task (MoA) (9 Stimuli - current weight, 9 Stimuli - ideal): *„Scale the size of the avatar to your current/ideal weight?"*
- Questionnaire about the similarity of the avatar to the participant's body



Apparatus

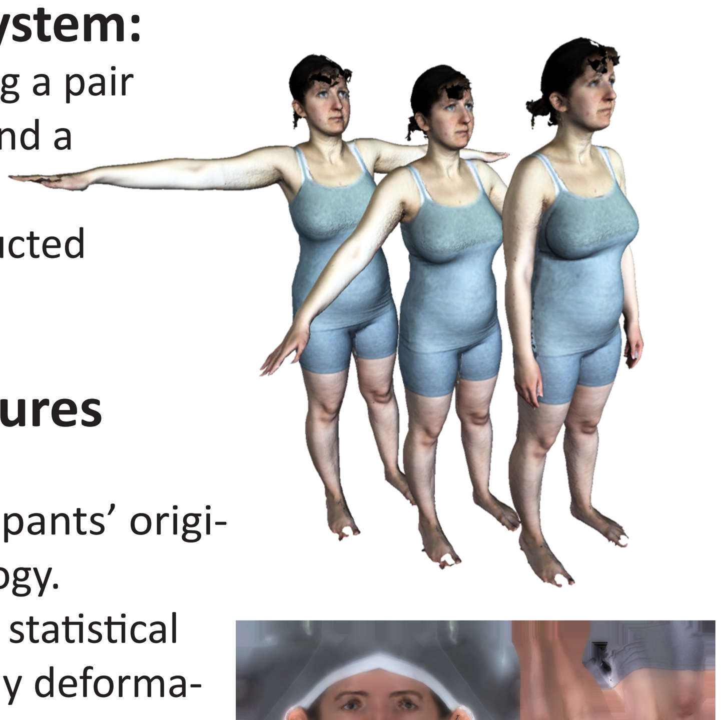


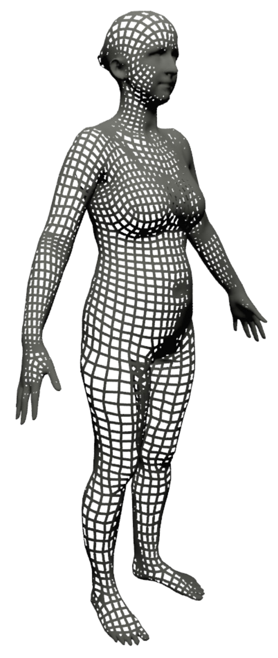
- A flat, stereoscopic, large-screen immersive display (Christie 176 SX+, 1400 × 1050 pixels, projection surface - 2.16 × 1.62 m)
- Head-tracking (ART© SMARTTRACK with two cameras, a rigid object with reflective markers attached to NVIDIA shutter glasses)

Visual stimuli - capturing body scans of the participants

3D full-body scanning system:

- 22 stereo units, each including a pair of black and white cameras and a five megapixel color camera
- The body geometry reconstructed with 1 mm accuracy





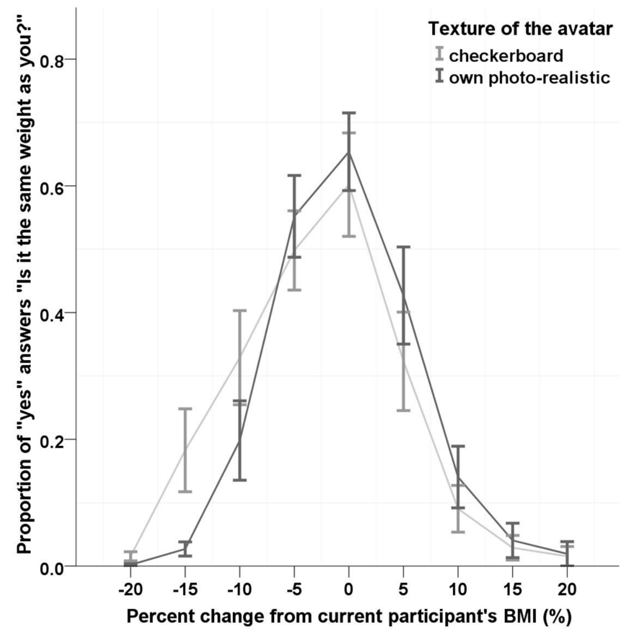
Obtaining 3D meshes and textures from the 3D scans

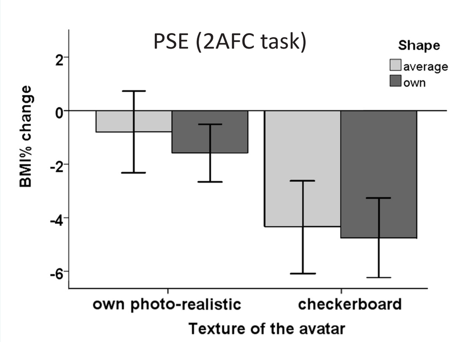
- 3D meshes and textures resemble the participants' original 3D scans but that shared a common topology.
- **3D meshes:** For the scan registration we use a statistical body model that compactly parameterizes body deformations in terms of deformations due to participants' identity and body pose [Hirshberg et al. 2012; Anguelov et al. 2005].
- **Textures:** A texture map is extracted per scan after decomposing the colors observed in the RGB images into albedo and irradiance [Bogo et al. 2014]. The final texture map was computed as the median of each individual scan map.

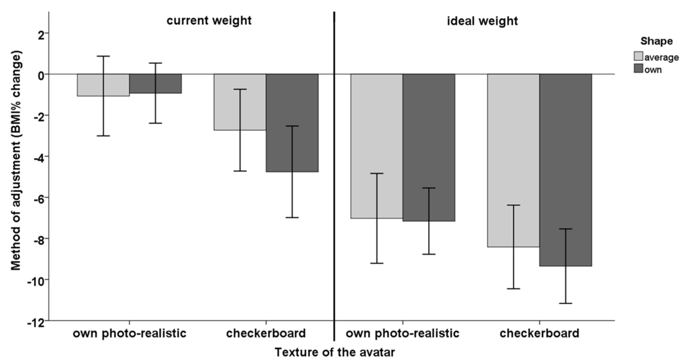
Results

2AFC task:

- Women are more willing to accept a thinner body as most similar to their actual body weight (slope). (p = 0.002)
- Avatars with a checkerboard pattern needed to be significantly thinner to accurately portray current weight than those with photo-realistic textures (PSE). (p = 0.003)





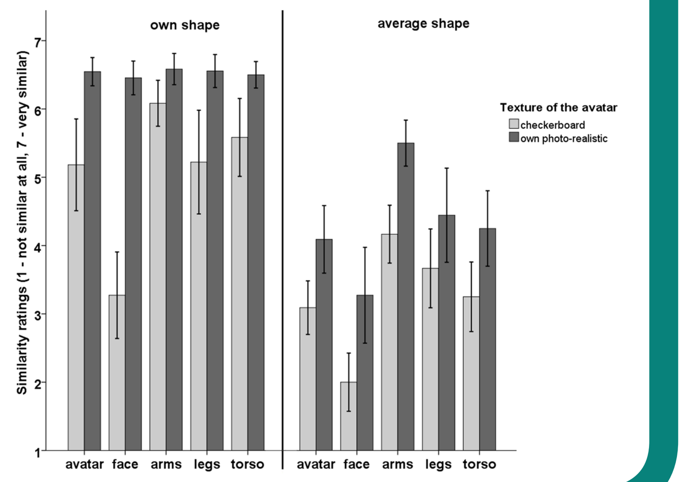


MoA task:

- Participants want to be significantly thinner than they are. (p < 0.001)
- The results provided by the MoA task have similar trend as the PSE from 2AFC task.

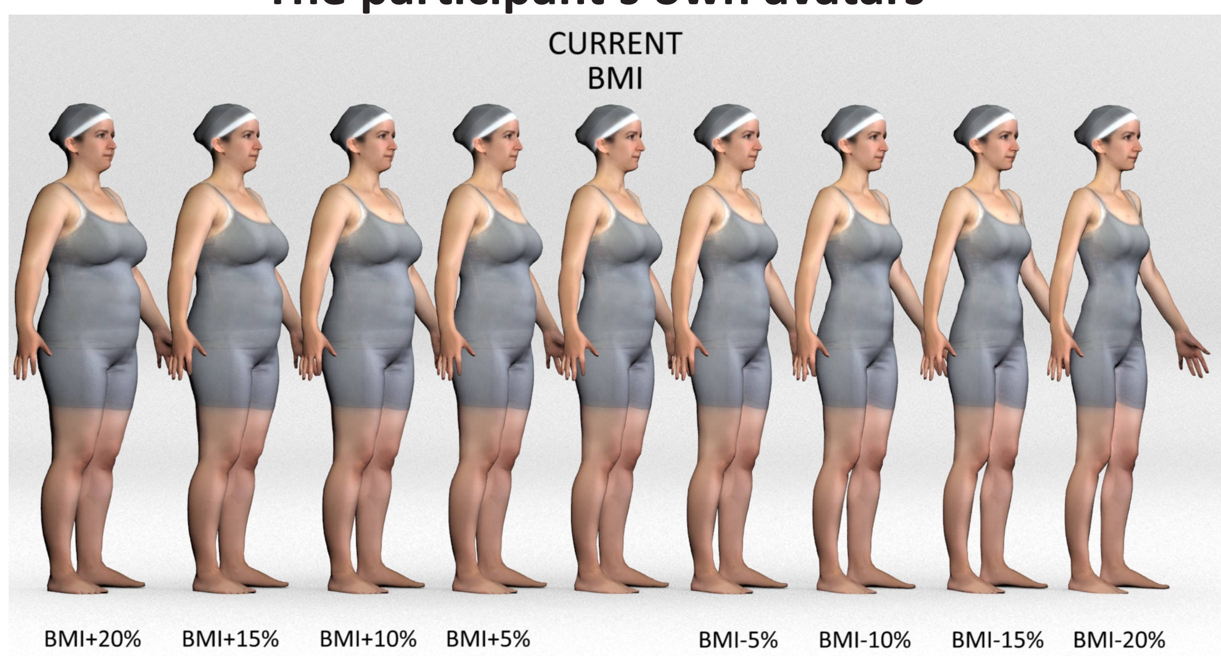
Participant's reports from the similarity questionnaire:

- Both shape and texture had an effect on the similarity with the participant. (ps=0.005)



Visual stimuli - generating avatars with varying BMIs

The participant's own avatars



- We alter the weight of the personalized avatars to produce changes in BMI (±20%, ±15%, ±10%, ±5%, 0% change in current BMI), while keeping other measurements fixed (height, arm length, inseam) [Weiss et al. 2011]. Given the weight of the participant *w*, height *h* and 3D registration, the participant's own avatars were constructed with 9 varying BMIs: $\left(1+\frac{\Delta bmi}{100}\right)\cdot\frac{w}{h^2}$, $\Delta bmi = \{0, \pm5, \pm10, \pm15, \pm20\}$
- The participant's own avatars are constructed by changing their identity deformation coefficients β, where *X* is a matrix which describes the mapping between β and the measurements (weight, height, arm length, inseam and deformation intercept):

$$\beta = \left[\frac{\Delta bmi}{100}.w,\ 0,\ 0,\ 0,\ 0\right]\cdot X$$

The participant's average avatars

- A different overall shape, still using the participant's height *h* and weight *w*.
- The individual (with height and weight, $h_{(avg)}$, $w_{(avg)}$) in the CAESAR dataset whose shape and body morphology was closest to the average female shape.
- The participant's average avatars are constructed by matching the height and weight of the participant's own avatars to the nine varying participant's BMIs previously computed by changing the deformation coefficients by:

$$\Delta\beta = \left[\frac{\Delta bmi}{100}\cdot w + \left(w - w_{\{avg\}}\right), \left(h - h_{\{avg\}}\right), 0, 0, 0\right].X$$

Discussion & Conclusion

- Own body weight was perceived veridically regardless of body shape (own or average)
- Perception of body weight can be manipulated by manipulating the texture of the avatar.
- Further investigation is necessary to provide conclusive results on whether the MoA task can be used instead of the 2AFC task.

Implications

The users should not be scanned each time when using a virtual reality application (games, training, or tools evaluating body perception of patients with eating disorders), if their personalized avatar:

- is within -6% to 0.8 % of the user's BMI regardless of shape (own or average)
- is textured so that it is perceived to have -6% to 0.8 % of the user's BMI

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